Chapter 9
Hardware, Software and Network Issues and Standards

9-1. General

Configuring and procuring the GD&S is a challenge, considering all the combinations of hardware, software and connectivity options available, but a solid set of requirements will allow purchases to be made with confidence. These requirements include the user needs, as defined in the systems requirements analysis, and non-user needs, the rules and regulations that must be followed during a system procurement, which may affect system design. GD&S design can be divided into hardware, software and network configuration.

9-2. Hardware

a. Compliance with standards. GD&S design must be done in phases and certain subjects must be dealt with in the early stages of system configuration. For instance, there are Federal standards that impose various standards on internetworking and interoperability among computer systems.

The United States Government has adopted the International Standard ISO/IEC 9945-1:1990, Information Technology - Portable Operating System Interface (POSIX) - Part 1: System Application Program Interface (API) [C Language}, as a Federal Information Processing Standard (FIPS 151-2, May 12, 1993). This standard defines a C programming language source interface to an operating system environment for scientific workstations, multi- user, and multi-tasking systems. This standard does not apply to the desktop or single user environment. This standard is for use by computing professionals involved in system and application software development and implementation. An objective of this standard is to promote portability of useful computer application programs at the source code level. FIPS 151-2 supersedes FIPS 151-1 and FIPS 151.

FIPS 146-2 (May 15, 1995), Profiles for Open Systems Internetworking Technologies (POSIT), removed the requirement that federal agencies specify Government Open Systems Interconnection Profile (GOSIP) protocols when acquiring computer networking products and services and communications systems or services.

b. Architecture. There are two basic system architectures in use, the client/server model and the stand-alone workstation model.

The client/server architecture allows all the large datasets and software packages to be stored on one central server system, freeing the other client machines to use their resources for other needs. This model provides better data management, allows for greater expansion due to the lower cost of typical client machines, which could be a simple X terminal, and provides single-point control of the databases and software used in the system. The server machine must have sufficient computing muscle and storage capacity to satisfy the needs of multiple users. This will drive up the cost of the initial server machine beyond what a typical stand-alone workstation would cost, but additional client machines will cost substantially less, particularly if that client machine is just an X terminal. The server can act solely as a file server for data storage and retrieval, or it can also provide computation services due to its fast CPU. In this aspect, the server could be viewed as a powerful standalone workstation with the capability to share its resources through a network.

The stand-alone system does not have shared resource requirements, so the performance of the CPU is not as important, but the system does require that every peripheral and upgrade path will be available during the lifetime of the GD&S. The purpose of a stand-alone GD&S could be to ensure strict security on the data since there are no channels for outside accesses. In addition, a stand-alone design can place networking as a low priority since it is rarely if ever used. This will severely limit the amount of data shared among GD&S and reduces the available resources the GD&S can use for scientific analysis.

c. Operating system (OS). The OS that is used must be compatible with the GD&S software and provide services to satisfy user needs and networking needs. In addition, consideration must be given to optional software and peripheral interfaces. The choice may be very simple if existing hardware has already been standardized on one OS; otherwise, the choices that are available are increasing and within three years the situation could change dramatically. The major OS choices available are UNIX (most are POSIX compliant), Windows, Windows NT (POSIX compliant), Windows95, DOS, VMS, and OS/2. Since the availability of these operating systems has grown over the past few years, the system designers choice of OS could be based on preference, but a shrewd choice can substantially benefit the GD&S and can prevent unnecessary costs when changes must be made. When choosing an OS for a time-critical GD&S, consider track record and dependability to be very important and avoid recent upgrades and opt for the older, more secure versions.

UNIX has been the overall standard in scientific computing over the last 15 years, mostly because of its wide availability over varying platforms and its close relationship with developers. UNIX offers standard networking based on TCP/IP protocol which is available with every version of UNIX. In addition, multiple users and multiple concurrent processes are supported, which makes it a likely choice for multiple user systems. Each user on a UNIX based system has a user account and password, which allows the system to maintain security and generate accounting information for billing or resource management. Recently, UNIX has undergone a graphical facelift much like Windows for DOS, which may come from different vendors. Through the X Consortium's graphical server standard many graphical environments are offered to provide a graphical user interface to UNIX, including HP-VUE, Motif, OpenWindows and SunView. This OS has been around for many years and has a very respectable track record and offers many services that other operating systems do not.

VMS is the proprietary OS developed by Digital Equipment Corporation (DEC) to operate on their line of VAX machines and has the same basic capabilities as UNIX minus the wide availability with different hardware and platforms. OS/2 is developed by International Business Machines (IBM) and offers a fully 32 bit operating system architecture for PC class machines. In addition, it provides compatibility with Microsoft Windows and DOS. Microsoft offers Windows NT, a 32-bit operating system with advanced networking and security features and maintains the standard Windows interface. Microsoft also offers Windows and DOS operating systems for PC class machines, which provides access to thousands of commercial software packages with substantially lower cost than a typical UNIX based software package. Apple's proprietary OS for the Macintosh line of computers maintains a simple plug-and-play peripheral interface.

d. Compatibility with existing hardware. Integration of a new GD&S into an existing system must be done with care and foresight in order to reduce incompatibility problems. If the existing systems are linked via a network and the new GD&S is proposed to be integrated into the existing network, then make sure the networking protocols and transports are supported on all machines. Some systems allow multiple protocols and transports to be used, however it is much more stable and safe to use the same network protocols (e.g., TCP/IP) and transports (e.g., 10BaseT). Additional cost can be saved if peripherals can be shared or used on all machines within the GD&S, consequently, verify that the existing peripherals can be used by the new GD&S hardware and software. It is generally a good idea to limit the number of different vendors and manufacturers to as few as possible in order to reduce maintenance contract costs and hardware/ software conflicts that arise between products from different manufacturers. This is especially true with software since developers rarely have the time and resources to test their products on every hardware configuration.

e. Upgradeability. Considering the pace that technology increases - a hardware generation is approximately seventeen months - it is inevitable that hardware and software upgrades will be desirable to increase performance and offer more complex analytical functions. It is very important to choose hardware and software that can be upgraded in as many ways as possible. Determine if CPU upgrades, RAM expansions, video expansions and storage expansions are available immediately or in the near future. Currently, the more flexible mode of upgrade is to offer a few hardware “slots” that are connected to the CPU bus architecture so that upgrade boards can be added to the system, such as to provide accelerated video and faster networking throughput.

f. Peripheral support. A GD&S is composed of a CPU, GD&S software, georeferenced datasets and additional peripherals that provide input and output to the system. There are many peripherals that should be accessible through the GD&S, such as scanners, digitizers, backup devices, GPS post processing, printers and plotters. Peripherals are an integral part of a GD&S and must be supported.

g. Maintenance and Management. Hardware maintenance is a very important job that generally requires a staff devoted to this task. Large computer systems of the past require expensive maintenance contracts and require constant attention. The purchaser has either the option to purchase a maintenance contract from the vendor or develop a trained staff for maintaining the computer equipment. Both options are costly, but system health must be maintained in order to have a working GD&S. This is especially true in a network, where if the network was corrupted or failed, then GD&S work would come to a halt until the problem could be fixed. In these situations, having service staff available may save a project from failure.

A System Administrator position should be created to manage the GD&S hardware and network products. The System Administrator shall maintain the system and develop standard operating procedures for the GD&S, such as user accounts, project schedules, scheduled downtimes for maintenance and CPU utilization reports.

h. Example configurations.

(1) SUN Sparcstation 10.

(a) 40 MB RAM.

(b) (2) 1.2 GB hard drives.

(c) Keyboard.

(d) Mouse.

(e) Wacom digitizing tablet.

(f) CD-ROM drive.

(g) Exabyte backup drive.

(h) 17' 256 color monitor.

(2) Intergraph Microstation.

(a) Keyboard.

(b) CD-ROM drive.

(c) 20' color monitor.

(d) Digitizing tablet.

(3) 486 33Mhz PC-compatible.

(a) 8 MB RAM

(b) 500 MB hard drive.

(c) Mouse.

(d) Keyboard.

(e) Syquest 88MB removable hard drive.

(f) CD-ROM drive.

(g) 14' color monitor.

(h) Ethernet networking card.

(i) 256 color Super-VGA video card.

(j) 600 dpi monochrome laser printer.

9-3. Software

a. Compliance with standards. In order for a GD&S to operate efficiently, a dependable strategy must be designed to handle importing and exporting datasets of differing formats and platforms. The Spatial Data Transfer Standard (SDTS), FIPS 173, is a mechanism for the transfer of spatial data between dissimilar computer systems. The SDTS specifies exchange constructs, addressing formats, structure, and content for spatially referenced vector and raster data. The SDTS Fact Sheet by the U.S. Geological Survey states that the advantages of SDTS include data and cost sharing, flexibility, and improved quality, all with no loss of information. This standard is mandatory for Federal agencies and will serve as the spatial data transfer mechanism for all Federal agencies. The U.S. Geological Survey (USGS) has been designated as the maintenance authority and will be producing software tools and guidelines for SDTS data encoding and decoding. They will also offer SDTS workshops and training in order to educate the spatial data community. The GDS software chosen must support SDTS as one of its data import/export format options.

For further information regarding the SDTS (FIPS 173), contact:

U.S. Geological Survey
SDTS Task Force
526 National Center
Reston, VA 22092
FAX: (703) 648-4270
E-mail: sdts@usgs.gov

b. Export/import raster and vector data. The GDS software must have the capability to import a variety of commonly available data formats without loss of information. This includes vector and raster data and associated descriptive attribute (tabular) data. At a minimum, the GDS software should have routines for importing commonly available data from government and commercial sources. These formats include DEM and DLG (USGS), TIGER-Line (Census Bureau), DTED and VPF (DMA) and standard commercial image formats from SPOT and EOSAT. In addition, the software should accept the widely used DXF exchange format, SDTS formats and ascii data.

Data export formats supported by the GDS software can be more limited. Data exchange between GDS using the same software is generally easy. The SDTS governs the exchange of spatial data between dissimilar systems among Federal agencies.

DMA has developed several data formats as military standards. However, these military standards are not FIPS and the GDS software chosen is not required to read or write data in these formats. The Vector Product Format (VPF), MIL-STD-2407 is a standard vector data format used by the Defense Mapping Agency and many of their map products are distributed in that format. DMA has also developed the Raster Product Format, MIL-STD-2411, for image and scanned data in compressed or uncompressed form.

c. Visual environment. There are certain minimum visual requirements that the GD&S environment must fulfill so that data analysis can be properly done. The GD&S must be able to display the datasets in a georeferenced environment and preferably allow the user to zoom into and away from the dataset based on certain spatial characteristics. Secondly, the user must be able to query the dataset either spatially or topically. Otherwise, the data remains strictly graphical and detailed analyses and reports can not be accurately performed. Third, the GD&S must provide the user with the capability to manipulate the dataset in some intelligent manner. Suppose the user must create a demonstration and the project calls for particular locations passing certain qualifications to be set to the color blue. The user will need to be able to manipulate the dataset as it is displayed to reflect these requirements. Data integrity should not be violated, but a certain latitude must be given to the user so that the environment can be as flexible and usable as possible.

d. Maintenance and management. GD&S maintenance requires a standard operating procedure for data archiving, data security and data modification. A typical data archiving schedule consists of daily data backups and weekly full system backups. Archiving data will ensure that any corruption or system failure will not destroy important data or software. Data security measures such as user and project login with password entry to the GD&S are standard. In a distributed GD&S network, data stewardship can be allocated such that data management and security can be centralized in one organization. However, a stand-alone GD&S workstation will require more control and might require strict passwords and possibly even read-only access to critical datasets. Computer systems are not fail safe and as many provisions that can be taken to prevent data loss or data corruption must be made. If datasets must be edited or updated, then a standard operating procedure should be drawn up for such an occasion, and a version control procedure should be implemented. Full backups of each successive data state should be kept in case the decision is made to reverse the changes.

9-4. Networking

a. Overview. In the early days of the personal computer revolution, people were content to use their computers for personal finance and possibly a little word processing. However, as hardware and software capabilities grew, they realized that these computers could offer them much more. Today's high-powered systems are used in all facets of business, including the quickly- growing GDS market. A computer is simply much better at GDS activities than people performing them by hand because it can analyze multiple multi-record databases and correlate an information base into useful results quick enough for them to be utilized in the real world. For example, the Federal Emergency Management Agency (FEMA) now uses a GDS to manage natural and man- made disasters. This GDS allows the agency to track hurricanes, estimate damage through simulations, and plan relief efforts in a matter of minutes; FEMA can now better manage relief aid for such disasters and then use the data gathered during one hurricane to plan for the next. Applications of GDS like this save time and lives, but are dependent upon the availability of large and often costly databases. Databases can quickly surpass your system's on-line storage capacity, requiring access to (and storage on) other machines, both local and remote. You may also have a need to send output from your GDS system to customers through quicker means than the postal service. Networking was born some twenty years ago to solve such problems. At that time, visionaries had an idea of computers becoming information resources for any number of different subjects. This idea has become a reality with the advent of the Internet. Once you are connected to the Internet, you have instant access to a wealth of information. Through electronic mail and bulletin boards (called “news groups” in Internet lingo), you can use a different kind of resource: a worldwide supply of knowledgeable people, their software, and their hardware.

This section provides a *brief* introduction to the subject of networking. This information could easily fill a book in its own right. The Internet, as described in this document, is still evolving along with the means of accessing it. Therefore, it should be known that the information presented in this document is current as of early August 1994 and may change within the next several years.

b. Introduction to networking and related concepts. Networking, simply put, is connecting your computers together so they can share information. Effective networking increases productivity by using computer resources, such as files, printers, and memory, more efficiently. A network puts the power of all your system's hardware and software at your fingertips.

Although there are many different types of networks, they fall into two general categories. Local area networks (LAN) are small groups of computers in close proximity connected together on a single line. Wide area networks (WAN), such as the Internet (although the Internet is really a collection of WAN, it can be viewed here as one large network) connect computers that can be as close as several hundred feet to as far as across the globe and typically include connections via cable, telephone lines, and satellites.

A network, in the physical sense, consists of cables or phone lines which directly connect computers, and special hardware installed in each computer which provide the means for communication. Computers on a network have established ways of communicating, called protocols. Protocols dictate which signals computers use across cables, how they tell one another that they have received information, and how they exchange information. These protocols are broken down into layers of service which specify the hardware/software interactions taking place on the network. Each layer is responsible for one piece of the communication and interacts only with the layers above and below it. For example, the International Organization for Standards (ISO) has a seven-layer protocol called the Reference Model for Open Systems Interconnection (OSI), as shown in Table 9-1 (lower layers are closer to hardware and higher layers are closer to the user).

A basic networking package consists of several services that allow your computer to connect to both local and wide area networks.

TCP/IP provides various protocols for networking communications that other networking packages, such as NFS, use. The TCP/IP package also provides end-user programs such as telnet and ftp that enable remote login and file transfer between systems running TCP/IP.

NFS allows you to export file systems to the network so that users on other computers can use them as if they were local, and to import file systems from remote systems to your own.

The Multichannel Memorandum Distribution Facility (MMDF) controls electronic mail communications between machines. MMDF is a service that provides users with transparent access to different networks and related mail transport protocols.

c. Local area networks.

(1) Description of a LAN. A local area network is a direct connection of computers in the same office or in adjacent buildings on a single cable. Within this small circle, each computer can communicate with every other computer on the LAN and share resources such as hard drives, printers, and any other peripherals. A LAN typically has one or more machines which perform services on behalf of the other computers in the LAN. These servers usually perform printing and file storage services. In addition, a server is also used to route connections to the Internet and other LANs around the world. The USACE policy on LANs is stated in IM Policy Memo 25-1-8, “Local Area Network (LAN) Design and Interoperability.”

(2) NFS/NIS. When the TCP/IP protocol was first developed and implemented on UNIX workstations, it was wonderful to be able to retrieve specific data from other machines on your LAN through such programs as ftp. However, with larger programs being developed, this became impractical. For example, most GDS systems require a large amount of online data which can quickly consume computer disk space. Instead of requiring each machine on the LAN to have its own copy of such data, it would be better to have one central copy on a server which everyone can access without having to transfer it to their machine. FTP does not provide the capabilities necessary to perform this task. In the early 80's Sun Microsystems developed a service called NFS (Network File System) which revolutionized the computer industry. NFS is a set of protocols which allow your computer to use files on other systems as if they were local. So, instead of obtaining files via ftp, you can read, write and edit files on remote machines. NIS is the service which manages all NFS activities. Its primary purpose is to ensure network consistency and maintain file access security in a LAN. NIS accomplishes this task by maintaining lists of users, passwords, and system access availability, and distributing the lists throughout the LAN. Each machine then knows who has access to specific files.

(3) Hardware and software issues. When the only computers you could buy included the UNIX operating system, building a LAN was not a problem because the basic architecture of each system's UNIX was the same. So, even if you had UNIX computers from two different vendors, you could be certain that the two machines would communicate without any problems on your LAN. Times have changed, and there are now many different operating systems available for every computer you can buy. Not all of them come with TCP/IP software. For example, while UNIX comes with such a package, MSDOS requires extra add-on software. Even with TCP/IP installed on both platforms, you still might not be able to share data due to physical differences between the machines such as the way one computer stores binary information as opposed to the other. The point is that you must put some thought into building your LAN. Make sure that all the different types of computers you wish to include will work cooperatively together or that you can purchase software to make them work together. Sun sells software which allows PCs to communicate with UNIX machines as do other vendors. Macintosh computers come ready with TCP/IP, but do not automatically support NFS. In addition, you should thoroughly investigate any hardware limitations you might encounter. If you plan out a strategy for purchasing equipment and computers for your LAN ahead of time, it will save you a world of data access and transfer nightmares.

d. The Internet. The Internet is a worldwide collection of WANs linking computers from government, academia, and industry. It allows easy access for computer users, and so is being used by the FGDC for the establishment of the National Geospatial Data Clearinghouse.

(1) History of the Internet. The Internet began as a Department of Defense experiment to develop a computer network which could operate without data loss in a battle during wartime when partial outages are likely. Because of

the premise on which it was developed, the ARPAnet (as the Internet was originally called), placed all the demands of data transmission and decoding on the network computers rather then the actual network links. This meant that the network did not have a vulnerable main transmission path or decoding hub. If one link vanished, the network computers determined this and rerouted their data through another path.

While this experiment was taking place, universities and other government agencies, who had most of the computing power in the United States, were looking for ways to link their systems together for research and educational purposes. However, since these organizations had no policies regarding computer purchasing, they found it difficult to successfully link computers from different manufacturers. The ARPAnet development solved this problem because of its basis on computers transmitting and decoding data themselves. If you wanted your computer to have access to other types of computers, you only had to write a piece of software for your computer which could send and receive data using the Internet Protocol (the method by which data is transmitted on the Internet). Demand to connect university and government mainframes grew, and Internet developers, responding to pressures, began to develop their Internet Protocol software on every possible type of computer. It quickly became the only practical way for computers from different manufacturers to communicate.

Roughly 10 years later, Ethernet local area networks (LAN) and workstations appeared on the scene. Most of them came with Berkeley UNIX, which came with the necessary Internet Protocol software built-in (this is where the fallacy that the Internet is UNIX started - although most of the Internet Protocol software originated on UNIX platforms, it is not part of the UNIX operating system itself). A new demand was created not only to connect large time-sharing mainframes to the ARPAnet but also to connect the entire LAN. Many different organizations started to build their own networks based on the Internet protocols because they found the existing ARPAnet communications too limiting due to its bureaucracy and staffing problems. Probably the most important of these new networks was the National Science Foundation's (NSF) NSFNET. In the 80's, the NSF established five centers for supercomputing activities. The fastest computers had previously been available only to the military and researchers from the government and universities. The NSF was now making such resources available to any world-wide researcher. Only five centers were established because of costs. To connect each center they needed dedicated, high-speed phone lines which were paid for by the mile. They realized that connecting each university to a center would bankrupt the agency, so they established regional networks with links to the supercomputing centers. Each university was connected to its nearest neighbor, and each computer in the network chain would forward requests between computers in the chain. This solution was very successful and has been adopted for modeling current networking activities.

In the late 80's, with network traffic increasing by about 15 percent per year, the Internet had grown to the point that its routing computers and the telephone lines connecting them were overloaded. The Federal government invested large sums of money into upgrading the entire network, and it continues to be the driving force behind supporting the Internet. These upgrades included new telephone lines with higher data transfer rates and more powerful data routing systems. With these enhancements to the Internet, it has become possible for more people to use the Internet not only in government, universities, and corporations, but also in their own homes. Various national companies, such as DELPHI, now offer Internet connections through standard modems. This type of connection may be slower than those available to organizations, but it is much more reliable than earlier bulletin board services to which the average home user had access. In addition, through such a connection, you have access to any computer on the Internet and a multitude of data and services.

(2) Internet security issues. Since the Internet is a global community of networks, anyone can have access to your system at any time. USACE Commands must control the types of access by establishing some basic security procedures before placing systems on the network. Each system administrator must be aware of the risks and take appropriate action to protect USACE systems without limiting access to the services available in Internet. USACE requirements for Internet Security are described in EP 25-1-97, Internet Implementing Procedures.

e. Obtaining Information from the Internet. This section will give a brief overview of services and applications which are used to access the Internet. Appendix C lists specific Internet sites that provide GD&S information.

(1) Telnet. Telnet is used for logging into other computers on the Internet or even to other computers on your LAN. Once you have established a connection, your machine is operating as a dummy terminal to display messages from the remote machine. It is used primarily for text-based purposes such as searching library card catalogs and other kinds of databases. Telnet generally does not offer file transfer capabilities between connected machines other than simple ASCII text.

Table 9-1
Reference Model for Open Systems Interconnection

Layer	Name	Description
7	Application	Defines how programs can communicate with each other.
6	Presentation	Performs any necessary data conversion.
5	Session	Establishes an enhanced connection (session) with other machines.
4	Transport	Makes sure information exchanged between computers arrives intact and without errors.
3	Network	Makes sure information coming from one computer arrives at the correct destination.
2	Data Link	Makes sure information gets from one end of the cable to the other intact.
1	Physical	Defines the way information travels on a cable. A common physical-level protocol is the IEEE 802.3 protocol, of which Ethernet is a subset.

(2) FTP. FTP (File Transfer Protocol) allows you to move files between machines. Once a connection is established, you may view the directory structure of the remote machine and move files to/from that computer, but you may not run any applications on that system. FTP is most useful for retrieving files from public archives that are scattered on the Internet. This is called an "anonymous FTP" because you do not need an account to access the remote computer.

(3) Electronic mail. Electronic mail, or e-mail, lets you send and receive messages to/from a person at a remote location on the Internet. E-mail is usually used for quick informal conversing over the Internet and as a means to quickly distribute textual information to multiple parties. Present E-mail software can even distribute embedded documents from popular word processors and other files.

(4) Network news. USENET is a system that lets you read (and post) messages that have been sent to public "news groups" (news groups are the equivalent of bulletin boards in the Internet community.) It is used primarily to converse with other people on any subject. For example, if you had a question about a problem with your laser printer, you could post a message to this service asking if anyone has a solution. USENET is the world's largest bulletin board service.

(5) Gopher clients. Gopher is a tool for browsing the Internet by selecting resources from a menu. Most often you will view the resources available in a directory tree structure. Gopher client software is designed to be user friendly so that it can help you get access to a particular item of interest. You do not have to worry about Internet addresses and once it has established a connection for you, the software can even retrieve files. Because of this, gopher clients are like ftp software packages with a user-friendly front-end. To use this type of package, the remote machine must be configured as a gopher server. This service is relatively new in the Internet community, so you will mainly find gopher servers at universities.

(6) WAIS. Wide Area Information Servers (WAIS) is another new service available on the Internet and is being used by FGDC. It is good for searching through indexed material and finding articles based on what they contain. WAIS is really a tool for working with large collections of data and databases. Almost any type of information can be indexed, and the retrieval software allows natural language string searches. For example, you could use WAIS to search indexed GDS databases for all references to Lake Michigan. In addition to searching for information in documents and databases, WAIS also has the capability to show you the information itself.

(7) The World Wide Web. The World Wide Web (WWW) is the newest information service to arrive on the Internet. This service is based on a technology called hyperlinking. Hyperlinking is a means of providing point-and-click access to other document sources - text, image, or sound - which relate to what you are currently viewing. Anyone who has used the Microsoft Windows Help program has seen this technology at work. Sections of text can have links to other sections through keywords. These keywords are highlighted via underlining, italics, etc. When you click on one of these keywords with a mouse, the software "fetches" the document corresponding to that link. The Web operates in the same way, but it goes much further. The links in the Web can be either text-based, pointing to other Internet sites and particular files which you may download to your machine, or multimedia pictures and audio which may be played on your computer. The purpose of the Web is to provide a subject-oriented means of browsing the Internet, which makes finding particular files and information much easier. Instead of locating files through text based searches with ftp and telnet, you are presented

with a paragraph on a particular file with a direct link to that file somewhere on the Internet.

Since the Web is relatively new, not many hyperlink Internet sites exist. These sites are identified by the letters “http” at the beginning of their address. In addition, it is up to the owners of each Internet site to determine whether or not to build hyperlink pages for their computers. If you are planning to let the public use your computer, it is a much more user friendly way to provide access to your services and resources. From a user's point of view, these hyperlink documents would be useless if there were no way to view them. Fortunately, the Web has been strongly endorsed by the Internet community, and there is an effort under way to develop such applications. Mosaic, which is being developed by the National Center for Supercomputing Applications, is the most popular of these hyperlink Internet browsing tools. This software offers all the features of the Web plus capabilities for WAIS, ftp, telnet, and gopher in one package, and is being developed for UNIX workstations running X-Windows, Macintoshes, and PCs with Microsoft Windows. The latest version of Mosaic is available free on the Internet with new alpha releases being distributed for all three environments about once every month. For further information on Mosaic, contact:

NCSA Documentation Orders
152 Computing Applications Building
605 East Springfield Avenue
Champaign, IL 61820-5518
(217) 244-4130
orders@ncsa.uiuc.edu